



Therapeutic Potential of *Piper betle*: An Amazing Nature's Medicinal Reservoir

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Abstract Medicinal plants are of proven value as potential therapeutics with the increase of resistant pathogens to commonly used anti-biotics and the emergence of new infectious diseases. The World Health Organization adopted a major policy change in accepting that most developing nations would have to make use of more traditional medical practices for primary health care. *Piper betle* L. belongs to family Piperaceae commonly known as Paan. It is extensively grown in Sri Lanka, India, Thailand, Taiwan and other Southeast Asian countries. Betelvine (*Piper betle* L.) is cultivated for its deep green heart shaped leaf for 15-20 million Indian and 2 billion foreign consumers annually. The crop provides Rs. 6000-7000 million of national income per year and at the same time leaves worth Rs. 30-40 million is exported to other countries. The leaves are not only used directly for chewing purposes but also possesses anti-oxidant, anti-inflammatory, anti-apoptotic, anti-cancer and anti-microbial properties. Besides, the leaves also contain eugenol rich essential oil (1-3%) which is the source for medicine, stimulant, anti-septic, tonic and other Ayurvedic formulations. The essential oil also contains chavibetol, caryophyllene and methyl eugenol which are the potent source for preparation in Ayurvedic medicine and herbal products. The present review aims to compile medicinal values of *Piper betle* generated through the research activity using modern scientific approaches and innovative scientific tools. It also attempts to provide a comprehensive account on biotechnological interventions made in betelvine aimed at complementing conventional programmes for improvement of this nutraceutically important cash crop. In this review emphasis is lead upon research related to therapeutic properties, phytochemistry, toxicity and ethnopharmacological value of *Piper betle* Linn.

Keywords Tamalapaku, *Piper betle* L., bioactivity, betelvine, chavibetol

Introduction

Ayurveda system of medicine is accepted as the Oldest written medical System is also supposed to be more effective in certain cases than modern therapies. The origin of Ayurvedic has been lost in prehistoric antiquity, but their concepts were between 2500 & 500 B.C in India. Ayurveda is accepted to be the oldest medical system. This came into existence in about 900 B.C. The word Ayurveda means ayur meaning life Veda meaning science. Thus Ayurveda literally means science of life. The Ayurveda is said to be an Upaveda of Atharvaveda. Charakasamhitha



is the first recorded book, with the concept of Ayurveda this describes 341 plants and plant products use in medicine Sushruta Samhitha 600 B.C as the next Ayurvedic literature that has special emphasis on surgery. It described 395 medicinal plants, 57 drugs of animal origin, 4 minerals and metals as therapeutic agents [1-3].

The term “medicinal plant” includes various types of plants used in herbalism (“herbology” or “herbal medicine”). It is the use of plants for medicinal purposes, and the study of such uses. The word “herb” has been derived from the Latin word, “*herba*” and an old French word “*herbe*”. Now a days, herb refers to any part of the plant like fruit, seed, stem, bark, flower, leaf, stigma or a root, as well as a non-woody plant. Earlier, the term “herb” was only applied to non-woody plants, including those that come from trees and shrubs. These medicinal plants are also used as food, flavonoid, medicine or perfume and also in certain spiritual activities [4,5].

An herb is a plant or plant part used for its scent, flavour or therapeutic properties. Herbal medicine products are dietary supplements that people take to improve their health. Many herbs have been used for a long time for claimed health benefits. They are sold as tablets, capsules, powders, teas, extracts and fresh or dried plants. However, some can cause health problems, some are not effective and some may interact with other drugs you are taking. Herbal medicine also called botanical medicine or phytomedicine refers to using a plant's seeds, berries, roots, leaves, bark, or flowers for medicinal purposes. Herbalism has a long tradition of use outside of conventional medicine. It is becoming more main stream as improvements in analysis and quality control along with advances in clinical research show the value of herbal medicine in the treating and preventing disease [6-8].

The world of nature has been a vast source for therapeutics for as long as thousands of years. Plant extracts play a vital role in the primary health care of about 80-85% of the world's total population. In Bangladesh, medicinal plant plays an important role in the health care system. Treated plant parts like leaves, flowers, barks and also roots are applied to treat diseases from a very long time. In spite of the extensive use of medicinal plants, their safety and efficacy have not yet been fully examined and further detailed analysis is therefore necessary for evaluation and standardization of the plant formulations. The reason behind the preference of medicinal plants over allopathic treatment options is that the medicines that the modern world offers at the moment are becoming resistant at a very high rate [9,10].

Plants have been used for medicinal purposes long before prehistoric period. Ancient Unani manuscripts Egyptian papyrus and Chinese writings described the use of herbs. Evidence exist that Unani Hakims, Indian Vaidis and European and Mediterranean cultures were using herbs for over 4000 years as medicine. Indigenous cultures such as Rome, Egypt, Iran, Africa and America used herbs in their healing rituals, while other developed traditional medical systems such as Unani, Ayurveda and Chinese medicine in which herbal therapies were used systematically [11].

Traditional systems of medicine continue to be widely practised on many accounts. Population rise, inadequate supply of drugs, prohibitive cost of treatments, side effects of several synthetic drugs and development of resistance to currently used drugs for infectious diseases have led to increased emphasis on the use of plant materials as a source of medicines for a wide variety of human ailments. Among ancient civilisations, India has been known to be rich repository of medicinal plants. The forest in India is the principal repository of large number of medicinal and aromatic plants, which are largely collected as raw materials for manufacture of drugs and perfumery products. About 8,000 herbal remedies have been codified in Ayush systems in India. Ayurveda, Unani, Siddha and Folk (tribal) medicines are the major systems of indigenous medicines. Among these systems, Ayurveda and Unani Medicine are most developed and widely practised in India [12,13].

Recently, WHO (World Health Organization) estimated that 80 percent of people worldwide rely on herbal medicines for some aspect of their primary health care needs. According to WHO, around 21,000 plant species have the potential for being used as medicinal plants. As per data available over three-quarters of the world population relies mainly on plants and plant extracts for their health care needs. More than 30% of the entire plant species, at one time or other was used for medicinal purposes. It has been estimated, that in developed countries such as United States, plant drugs constitute as much as 25% of the total drugs, while in fast developing countries such as India and China, the contribution is as much as 80%. Thus, the economic importance of medicinal plants is much more to countries such as India than to rest of the world. These countries provide two third of the plants used in modern system of medicine and the health care system of rural population depend on indigenous systems of medicine.



Treatment with medicinal plants is considered very safe as there is no or minimal side effects. These remedies are in sync with nature, which is the biggest advantage. The golden fact is that, use of herbal treatments is independent of any age groups and the sexes. The ancient scholars only believed that herbs are only solutions to cure a number of health related problems and diseases. They conducted thorough study about the same, experimented to arrive at accurate conclusions about the efficacy of different herbs that have medicinal value. Most of the drugs, thus formulated, are free of side effects or reactions. This is the reason why herbal treatment is growing in popularity across the globe. These herbs that have medicinal quality provide rational means for the treatment of many internal diseases, which are otherwise considered difficult to cure [14-16].

Medicinal plants such as *Aloe*, *Tulsi*, *Neem*, *Turmeric* and *Ginger* cure several common ailments. These are considered as home remedies in many parts of the country. It is known fact that lots of consumers are using Basil (*Tulsi*) for making medicines, black tea, in *pooja* and other activities in their day to day life. In several parts of the world many herbs are used to honour their kings showing it as a symbol of luck. Now, after finding the role of herbs in medicine, lots of consumers started the plantation of *Tulsi* and other medicinal plants in their home gardens. Medicinal plants are considered as rich resources of ingredients which can be used in drug development pharmacopoeial, non-pharmacopoeial or synthetic drugs. A part from that, these plants play a critical role in the development of human cultures around the whole world. Moreover, some plants are considered as important source of nutrition and as a result of that they are recommended for their therapeutic values. Some of these plants include ginger, green tea, walnuts, aloe, pepper and turmeric etc. Some plants and their derivatives are considered as important source for active ingredients which are used in aspirin and toothpaste etc. Apart from the medicinal uses, herbs are also used in natural dye, pest control, food, perfume, tea and so on [17-19].

In many countries different kinds of medicinal plants/ herbs are used to keep ants, flies, mice and flee away from homes and offices. Now a days medicinal herbs are important sources for pharmaceutical manufacturing. Recipes for the treatment of common ailments such as diarrhoea, constipation, hypertension, low sperm count, dysentery and weak penile erection, piles, coated tongue, menstrual disorders, bronchial asthma, leucorrhoea and fevers are given by the traditional medicine practitioners very effectively. Over the past two decades, there has been a tremendous increase in the use of herbal medicine; however, there is still a significant lack of research data in this field. Therefore since 1999, WHO has published three volumes of the WHO monographs on selected medicinal plants. Herbs such as black pepper, cinnamon, myrrh, aloe, sandalwood, ginseng, red clover, burdock, bayberry, and safflower are used to heal wounds, sores and boils. Basil, Fennel, Chives, Cilantro, Apple Mint, Thyme, Golden Oregano, Variegated Lemon Balm, Rosemary, Variegated Sage are some important medicinal herbs and can be planted in kitchen garden. These herbs are easy to grow, look good, taste and smell amazing and many of them are magnets for bees and butterflies. Many herbs are used as blood purifiers to alter or change a long-standing condition by eliminating the metabolic toxins. These are also known as 'blood cleansers'. Certain herbs improve the immunity of the person, thereby reducing conditions such as fever. Some herbs are also having anti-biotic properties. Turmeric is useful in inhibiting the growth of germs, harmful microbes and bacteria. Turmeric is widely used as a home remedy to heal cut and wounds [20-22].

In these modern times, the concept of a return to the “roots” of medicine is starting to become more and more popular. Scientific progress has provided new approaches for the analysis of different folk herbs that are used in various cultures. The pharmacological properties of plants used as food, medicine or for spiritual purposes during the centuries have been confirmed through new approaches to their analyses. The heritage of using some plants in traditional medicine is continuously being corroborated in terms of their effects through scientific inquiry. One of the widely distributed plant genera in pantropical regions is the genus *Piper*. *Piper* plants are also known under the common name “pepper” [23].

The presence of oil cells in the structures of almost all *Piper* species places them in the group of aromatic plants. Besides their well-known uses as culinary spices, the secondary metabolites isolated from *Piper* plants show wide ranging human health effects. *Piper* species are aromatic plants used as spices in the kitchen, but their secondary metabolites have also shown biological effects on human health. These plants are rich in essential oils, which can be



found in their fruits, seeds, leaves, branches, roots and stems. Some *Piper* species have simple chemical profiles, while others, such as *Piper nigrum*, *Piper betle*, and *Piper auritum*, contain very diverse suites of secondary metabolites. In traditional medicine, *Piper* species have been used worldwide to treat several diseases such as urological problems, skin, liver and stomach ailments, for wound healing, and as anti-pyretic and anti-inflammatory agents. In addition, *Piper* species could be used as natural anti-oxidants and anti-microbial agents in food preservation [24,25].

Back ground

Piper betle or Betelvine deep green heart shaped vary famous leaves belongs to the family of Piperaceae and has over 2000 species and indigenous to India. A well prepared betel quid is still regarded as an excellent mouth freshener and mild vitalize, routinely served on the social, cultural and religious occasions like marriage, religious festivals, sraddha ceremony (religious function performed after cremation) etc. The most likely place of origin of *Piper betle* vine is Malaysia but it is also cultivated in India, Srilanka, Bangladesh, Burma and Nepal. *Piper betle* leaves are popularly known as Paan leaves in India, which are consumed by about 15-20 million people in the country [26-28].

Table 1: Vernacular names

Sanskrit	Nagavallari, Nagini, Nagavallika, Tambool, Saptashira, Mukhbhushan, Varnalata
Telugu	Nagballi, Tamalpaku
Hindi	Paan
English	Betel, Betel pepper, Betel-vine
Urdu	Paan
Malayalam	Vettila
Tamil	Vettilai
Bengali	Paan, Paana
Assamese	Paan, Paana
Arabic	Tambol, Tambool
Guajarati	Nagarbael
Marathi	Nagbael
Kannada	Veeleyada yele, Eleballi
Konkani	Phodi paan
Arabic	Tanbol
Persian	Burg-e-Tanbol
Nepalese	Naagavallii, Paan
Indonesia	Bakik serasa, Daun sirih
German	Betelpfeffer, Betel-Pfeffer

Table 2: Taxonomic classification of *Piper betle*

Kingdom	Plantae
Subkingdom	Tracheobionta
Infrakingdom	Streptophyta
Superdivision	Spermatophyta
Division	Magnoliophyta
Class	Magnoliopsida
Subclass	Magnoliidae
Order	Piperales
Family	Piperaceae
Genus	<i>Piper</i>
Species	<i>P. betle</i>
Binomial name	<i>Piper betle</i> L.





Figure 1: Piper betle plant



Figure 2: Piper betle leaves



Figure 3: *Piper betle* seeds

Plant description

It is a Perennial dioecious creeper. Stems are semi woody, climbing by means of short adventitious roots. Leaves are 10-20cm long, broadly ovate, slightly cordate and often unequal at the base, shortly acuminate, glabrous, glaucous on both sides, bright green or yellowish, petiole stout 2.0-2.5cm long. Male spikes cylindrical dense, female spikes 2.5-5.0cm long, pendulous. Fruits are rarely produced, often sunk in the fleshy spike, forming nodule-like structures. Betel leaf is the most valuable home remedy for common illness. The betel (*Piper betle*) is a spice whose leaves have medicinal properties. The branches of the plant are swollen at the nodes. The plant has alternate, heart-shaped, smooth, shining and long-stalked leaves, with pointed apex. It has five to seven ribs arising from the base; minute flowers. Betel is a native of central and Eastern Malaysia. It spread at a very early date throughout tropical Asia and later to Madagascar and East Africa. In India, it is widely cultivated in Tamil Nadu, Madhya Pradesh, West Bengal, Orissa, Maharashtra and Uttar Pradesh. Offering betel morsel (pan-supari) to guests in Indian subcontinent is a common courtesy [29-31].

Betelvine is the most important and useful asexually propagated cash crop having various cultivars. It belongs to Piperaceae family and is a shed loving plant. It has a perennial creeper and bears leaves that are 4–7 inch long and 2–4 inch broad. It bears both male and female flowers. This plant is economically, medicinally and traditionally important in the whole world. The betel leaves are mainly used as mouth freshener and is also well known for curing many communicable and non-communicable diseases like cold, cough, bronchial asthma, rheumatism, stomachalgia and used to treat other diseases like bad breath, boils and abscesses, conjunctivitis, constipation, swelling of gums, cuts and injuries. The essential oil of betel leaves possess anti-bacterial, anti-protozoan and anti-fungal properties. From the study it is known that the aqueous extract of betelvine reduces the adherence of early dental plaque bacteria. The important constituents of *P. betle* have become a good source of income and mode of foreign exchange for the country. The size and colour of the betel leaf is the most important factor for the betel producers to categorise products in the market. On the basis of chemical constituents of leaf essential oils, five prominent groups of betelvine landraces, namely Bangla, Kapoori, Meetha, Sanchii and Desawari have been recognized. The betelvine is called as ‘green gold of India’ as about 20 million people derive their livelihood directly or indirectly from production, processing, handling, transportation and marketing of betel leaves in India [31-34].





Figure 4: *Piper betle* flower

Physical Characters

A green leafy vine growing as a ground cover or small climber, very similar in growth habits to pepper. The betel leaf plant is a branching vine that may climb as high as 10-15ft, although it often grows as an understory ground cover. It is generally too tender to grow outside of the tropics. The plant growing environment prefers warm, humid conditions, but can tolerate some drought [35,36].

Phytochemicals¹

Piper betle contains a wide variety of biologically active compounds whose concentration depends on the variety of the plant, season and climate. Chemical compositions of essential oil constitute safrole present in the leaf, stalk, stem, root and beta-phellandrene present in the fruit. The presence of hydroxychavicol acetate, allylpyrocatechol piperbetol, isoeugenol, anethole, stearic acid, methyl eugenol, carvacrol, polyphenol, alkaloids, saponins, tannin, steroids and other compounds are also found in *Piper betle*. The aroma of betel leaf is due to the presence of essential oils, consisting of phenols and terpenes. The active ingredient of *Piper betle* oil which is obtained from the leaves is primary a class of allyl benzene compounds, chavibetol, chavicol, estragole, eugenol, methyl eugenol and hydroxycatechol [36-38].

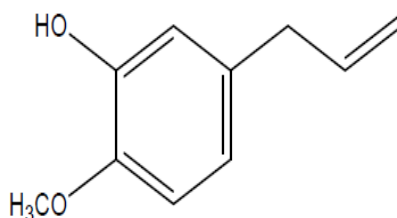


Figure 5: Chemical structure of chavibetol

Bio-active components (% of components)

Major constituents of *Piper betle* are chavibetol (53.1%) and chavibetol acetate (15.5%). Other constituents were allylpyrocatechol diacetate (0.71%), campene (0.48%), chavibetol methyl ester (0.48%), eugenol (0.32%), α -pinene (0.21%), beta-pinene (0.21%), α -limonene (0.14%), safrole (0.11%) and 1,8-cineole (0.04%). Hexane fraction of leaf stalks yielded four aliphatic compounds in pure form pentadecyl 6-hydroxytridecanoate, pentatriacontanol, methyl hexacos-7-enoate and 6,9-heptacosadiene. The principle chemical constituents of *Piper betle* were found to be polyphenols like eugenol, chavicol, charvacrol, chevibetol, catechol and allyl pyrocatechol and vitamin-C, which



were reported to exhibit strong anti-oxidant activity. Further these polyphenols exert their protective activities through their superior radical scavenging and immune modulating potentials [39-42].

Nutritional composition

The proximate analysis of the leaves of *Piper betle* showed that, it contained macro and micro nutrients as well as phytochemicals were given in the following Table 3 [42,43].

Table 3: Elemental composition of *Piper betle*

S. No.	Constituents	Approximate composition
1	Water	85-90%
2	Proteins	3-3.5%
3	Fat	0.4-1.0%
4	Minerals	2.3-3.3%
5	Fiber	2.30%
6	Chlorophyll	0.01-0.25%
7	Carbohydrates	0.5-6.10%
8	Energy	44 kcal/100g
9	Essential oils	0.08 - 0.2%
10	Iodine	3.4 µg/100g
11	Iron	0.005-0.007%
12	Calcium	0.2-0.5%
13	Potassium	1.1-4.6%
14	Nicotinic acid	0.63-0.89 mg/100g
15	Vitamin C	0.005-0.01%
16	Vitamin A	1.9-2.9 mg/100g
17	Thiamine	13-70 µg/100g
18	Riboflavin	1.9-30 µg/100g
19	Tannins	0.1-1.3%
20	Nitrogen	2.0-7.0%
21	Phosphorus	0.05-0.6%

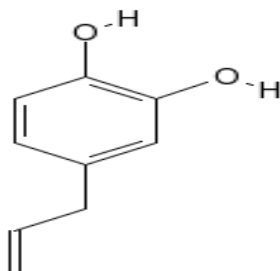


Figure 6: Chemical structure of hydroxychavicol

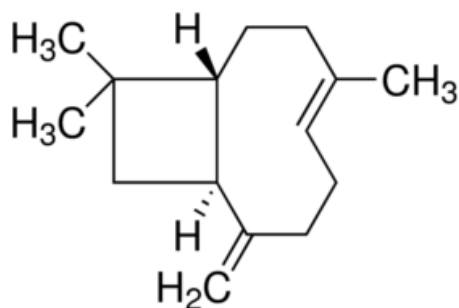


Figure 7: Chemical structure of caryophyllene

Traditional uses of *Piper betle*

- The paste of *Piper betle* leaves assorted with salt and hot water able to be administering for filariasis.
- For curing obesity, one *Piper betle* leaf mix with *Piper nigrum* is prescribed for two months.
- Juice of *Piper betle* with honey is accommodating to treat coughs, dyspnoea, and in indigestion, amongst children.
- Leaves of *Piper betle* smeared with oil are useful on the breasts of lactating women; it is supposed to promote milk secretion.
- A local application is recommended for inflammatory swelling such as orchitis, arthritis and mastitis.
- For childhood and old people, leaves are mixed with mustard oil, warmed and are apply to the chest for treatment to reduce cough and dyspnoea.
- Recovers bad breath, body odour and prevent tooth decay.
- Prevents and treats vaginal ejection, and reduce itching of the vagina.
- Stop bleeding in the nose.
- It contains vitamins such as thiamine, niacin, riboflavin and carotene.
- Juice of leaves is used as stomachic and febrifuge.
- In India, leaves used for curing eczema, lymphangitis, asthma and rheumatism.
- Paste of leaves is applied on cuts and wounds.
- Oil used for irritation in throat, larynx, bronchi, gargle and inhalation in diphtheria.
- Roots with black pepper used to generate sterility in women [44].



Figure 8: Betel quid

Ethnobotanical uses

- Betle leaves are advantageous in pulmonary infection in childhood and old age. The leaves mixed in mustard oil warmed and applied to the chest to relive cough and intricacy in breathing.
- Limited application of the leaves is efficient in procuring sore throat. The flattened fruit or berry should be mixed with honey and used to reduce irritating cough.
- Betle leaves are helpful for the treatment of nervous pain, nervous exhaustion and debility. The extract of few betle leaves, with honey serve up as a good tonic.
- On applied locally, betle leaves are valuable in the treatment of swelling such as arthritis and orchitis i.e. inflammation of the testes.
- Betle leaves also shows analgesic and cooling properties.
- It is also a priceless remedy for boils. A leaf is lightly warmed till it gets soft, and then coated with a layer of castor oil. The oiled leaf is placed over the inflammation.



- A hot poultice of the leaves or their extract mixed with some bland oil as refined coconut oil which can be applied to the loins with beneficial results in lumbago.
- The leaves can also be used to heal wounds. The juice of the leaves should be extracted and applied locally to the wounds.
- The application of leaves coating with oil and said to encourage secretion of milk when applied over the breast during lactation.
- According to Unani system, these leaves have a sharp taste and good smell which helps to improve appetite.
- It also used as a tonic for brain, heart and liver. It also helps to promote healthy teeth and skin.
- It helps in procurement of disorders in physiological function of body, Skin diseases, and several eye diseases.
- Betle leaf also contains diuretic property. Juice of leaves given with milk or honey helps in easing urination.
- Betle leaf is used in aphrodisiac i.e. an agent that stimulates sexual desire.
- The essential oils which contains in the leaves are anti-bacterial, anti-protozoal and anti-fungal properties. Therefore, the oil kills or inhibits expansion of outrageous bacteria causing typhoid, cholera, tuberculosis etc and helps in proper evaluation and exploitation.
- The leaves are nutritive and hold considerable quantity of vitamins and minerals and therefore, six leaves with a small bit of slaked lime are said to be equivalent about 300 ml of cow milk mainly for the vitamin and mineral nutrition.
- The leaves also hold the enzymes like diastase and catalase as well as major amount of all the essential amino acids except lysine, histidine, and arginine, which are found only in traces [44,45].

Ethnopharmacological studies

The plant is known to possess various biological and pharmacological activities and the various active compounds responsible for the activities are specified in Table 4 [34,44-49].

Table 4: Ethnopharmacological values of *P. betle*

Plant part	Activity
Leaves	Anti-cancer activity, Anti-allergic activity, Anti-malarial activity, Anti-filarial activity, Anti-microbial activity, Protective and Healing activity, Immunomodulatory activity, Gastroprotective activity, Hepatoprotective activity, Platelet inhibition activity, Anti-oxidant activity, Anti-fertility activity, Cholinomimetic effect, Anti-asthmatic effect, Anti-halitosis activity, Anti-haemolytic activity, Anti-nociceptive activity, Anti-hypercholesterolemic activity, Anti-mutagenic effects, Anti-histaminic activity, Anti-inflammatory effects, Anti-fungal activity, Cytotoxic activity, Anti-tuberculosis activity, Anti-dengue activity, Neuroprotective activity, Radioprotective activity, Anti-depressant activity, Anti-cholinesterase inhibitory activity, Anti-adipogenic/Weight reducing potential
Leaves (Others)	Oral hygiene, Skin anti-septic, Local anaesthetics action, Chlorophyllase activity, Anti-adherence effect, Anti-dermatophytic action, Anti-photosensitizer, Anti-Leishmaniasis





Figure 9: Piper betle creeping

Acute toxicity study

An acute oral toxicity assay was performed using healthy, non-pregnant, adult female, Swiss albino mice (weight range, 25–30g) divided into six different groups. Increasing oral doses of methanolic extract of Piper betle leaves (50, 100, 200, 500 and 1,000mg/kg body weight) in distilled water were administered at 20ml/kg to the different test groups. The normal group received distilled water only. Following treatment, the mice were allowed to feed *ad libitum* and observed for 48 h for any mortality or behavioural changes [49,50].

Conclusion and Future Prospects

Till date good progress has been made regarding the chemical profiling, bioactivity studies and disease management for betelvine which has been illustrated in Table 4. Identification of constituents in different landraces using modern gas chromatographic techniques could be useful for future elite landraces selection and their improvement programmes. At the same time efforts should be made on characterization of most of the available landraces which could be useful for resolving synonym problem and their proper authentication. In consideration of the proven therapeutic value of *P. betle* proper characterization could be useful for long term research for drug development. Efforts are to be intensified towards obtaining promising landraces with high eugenol and chavibetol content. In addition to its bioactivity studies attention may also to be addressed towards proper authentication of a particular landrace and their conservation for continuous supply. As plant secondary metabolites are always affected by soil and environmental factors it is also imperative to study the effect of abiotic factors on production and quality of betelvine. Further standardization of factors for quality and quantity of betelvine essential oil and extracts could be the future line of research before clinical trial and large commercial cultivation. Recent biotechnological tools like chromatography, NMR other functional genomics techniques could be explored to find out new compounds with active potential from this unexplored plant species. Further study is needed in chlorophyllase activity for long term storage and improvement of export potential of betelvine leaf. Special attention is needed in pest and disease



management in betelvine for development of new and improved varieties. Genetic diversity assessment using molecular markers should be intensified taking maximum number of landraces. In essence, biotechnological intervention has opened up new horizon for genetic improvement, proper authentication and identification of elite chemotypes of this medicinally and economically important cash crop.

This review is submitting to great potential of medicinal and Nutrients value. Piper betel is known to worldwide and consumed frequently as mouth freshener and also used as potent source for novel therapeutically value. This value reveals it to be fit for its future usage as a promising source for treating various conditions. Therefore, the same with lots of biological activities and has a tremendous strength to come out as a future herb medicinal and nutrients uses. Hence, further critical studies on leaf extract should be necessary for improving its uses for various medicine productions. During cultivation, betelvine affected by some diseases, that causes great loss to the farmers. So, disease identification must be necessary at an early stage and preventive action can be taken before the disease starts to spread. Therefore, in the near future the standardization and stabilization studies on the leaf extract can be carried out which can help in improving its usage for varied medicinal usage. This adequately justifies its nomenclature as the “Green Gold of India”.

Declaration of competing interest

The authors report no conflicts of interest in this work.

Author contributions

All authors contributed to data collection, drafting or revising the article, gave final approval of the version to be published, and agree to be accountable for all aspects of the work.

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